PREDICTING F/A-18 FLEET REPLACEMENT SQUADRON PERFORMANCE USING AN AUTOMATED BATTERY OF PERFORMANCE-BASED TESTS

G.R. Griffin and R.N Shull

Naval Aerospace Medical Research Laboratory
Naval Air Station
Pensacola, Florida 32508-5700

Reviewed and approved 26 March 1990

J. A. Brady

J. A. BRADY, CAPT, MSC USN
Commanding Officer

This research was sponsored by the Naval Medical Research and Development Command under work unit no. 63706N M0096 M00960.01.

The views expressed in this article are those of the authors and do not reflect the official policy or position of the Department of the Navy, Department of Defense, nor the U.S. Government.

Trade names of materials and/or products of commercial or non-government organizations are cited as needed for precision. These citations do not constitute official endorsement or approval of the use of such commercial materials and/or products.

Volunteer subjects were recruited, evaluated, and employed in accordance with the procedures specified in Department of Defense Directive 3216.2 and Secretary of the Navy Instruction 3900.39 series. These instructions are based upon voluntary informed consent and meet or exceed the provisions of prevailing national and international guidelines.

REPORT DOCUMENTATION PAGE	*Form Approved* *OMB No. 0704-0188*

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
March 1990

3. REPORT TYPE AND DATES COVERED
Interim Jun 86 - Jun 89

4. TITLE AND SUBTITLE
Predicting F/A-18 Fleet Replacement Squadron Performance using an Automated Battery of Performance-based Tests

5. FUNDING NUMBERS
63706N
M0096.001 0151

6. AUTHOR(S)
Griffin, G. R. and Shull, R. N.

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Naval Aerospace Medical Research Laboratory
Bldg. 1953, Naval Air Station
Pensacola, FL 32508-5700

8. PERFORMING ORGANIZATION REPORT NUMBER
NAMRL-1354

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Naval Medical Research and Development Command
National Naval Medical Center, Bldg. 1
Bethesda, MD 20814-5044

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

Several studies have suggested the possibility of predicting operational performance in fleet aviation environments. This report concerns the use of an automated performance-based test battery, involving cognitive and psychomotor functioning, to predict the operational performance of fighter pilots. Two groups of pilots who were completing fleet replacement squadron (FRS) training for the F/A-18 were tested on this battery. The older and more experienced pilot group got higher FRS grades than did the other group; test performance between these two groups was not significantly different. Those few significant correlations found between the test measures and the FRS grades were illogically patterned and of insufficient quantity or strength to demonstrate any reliable predictive ability. This could have been due to the homogeneous nature of each of these subject groups in terms of piloting skills and abilities.

JG

Training

14. SUBJECT TERMS
Pilot Selection, Pipeline Assignment, Psychomotor Ability, Cognition, Dichotic Listening, Multitask Performance, Fleet Aviation Performance, Jet Fighters, Flight

15. NUMBER OF PAGES
13

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std Z39-18
298-102

SUMMARY PAGE

THE PROBLEM

Many studies have suggested the possibility of predicting operational performance in fleet aviation environments. Research is currently being conducted to develop relevant predictor tests, the results of which might aid in the making of decisions concerning aircrew selection, training pipeline assignment, and posttraining aircraft assignment. The current approach is to use an automated performance-based test battery involving cognitive and psychomotor functioning to predict the operational performance of fighter pilots.

FINDINGS

Two groups of pilots who were completing fleet replacement squadron training (FRS) for the F/A-18 were tested on this battery. The older, more experienced pilot group had higher FRS grades than did the other group, but test performance between these two groups was not significantly different. The few significant correlations between test measures and FRS grades were too illogically patterned with insufficient quantity or strength to be reliable predictors. This may be due to the homogeneous nature of each subject group in terms of piloting skills and abilities.

RECOMMENDATIONS

We recommend continued research of this type utilizing this test battery be continued with some changes. Differences in test performance among both similar and different pilot-type groups should be investigated as thoroughly as possible. Replication is crucial if this testing methodology is to be considered for purposes of selection and assignment in naval aviation. Changes in test structure that would increase testing efficiency, or apparatus that would increase or at least stabilize test subject effort should be investigated. Also, research in which subjects are tested before flight training and then followed throughout their aviation career is needed. Such long-term studies would allow a more accurate assessment of the predictive ability of these tests choosing the best candidate for a particular aviation platform or community.

Acknowledgments

We gratefully acknowledge Mr. Peter Collyer and Ms. Kathy Vogel for assistance in programming and modifying the cognitive/psychomotor test battery, Mr. Alfred Thomas for care and diligence in running subjects, and Dr. David Blower for reviewing the manuscript and verifying the canonical analyses.

INTRODUCTION

Research is being performed at the Naval Aerospace Medical Research Laboratory (NAMRL) to predict fleet aviator inflight performance using cognitive and psychomotor tests. The goal is to develop relevant predictor tests that will reliably relate to simulated and actual flight performance. Results of this effort may aid in decisions regarding initial pilot selection, training pipeline assignment, and posttraining aircraft assignment.

A number of Navy research efforts have been marginally successful in predicting various aspects of operational aviator performance. For example, peer ratings from Navy preflight training were useful in identifying both successful and unsuccessful aviators in combat in Vietnam (1). A study (2) of F-4 Replacement Air Group (RAG) training during the midsixties resulted in a prediction equation that could have possibly reduced RAG attrition from 13.3% to 8.3%. When F-4 Air Combat Maneuvering (ACM) on the Tactical Aircrew Combat Training System range in the late seventies was evaluated, the authors found that three criterion measures (angle-of-tail, closing velocity, and indicated air speed) were significantly related to ACM performance (3). A combination of psychological tests and actual flight performance measures successfuly predicted F-4 carrier landing performance (4). Others found that a relatively small set of RAG criterion scores reliably predicted final overall RAG grade (5). The two most promising scores (carrier qualification power/nose control, and offensive ACM) accounted for 73% of the variance with the final overall RAG grade. In two subsequent studies (6,7), the authors reported that a regression equation based on the performance of an East coast F-4 RAG reliably predicted performance of a West coast F-4 RAG, and an overall experience measure combined with seven undergraduate training grades reliably predicted the overall RAG grade. More recently, automated dichotic listening and psychomotor (cursor tracking) tests predicted some elements of the ACM performance of Marine F-4 pilots on an instrumented training range (8).

These studies suggest the possibility of predicting operational performance in fleet aviation environments. Our approach is to use automated performance-based tests of cognitive and psychomotor functioning to predict aviator performance in operational settings. This report documents an attempt to use an automated battery of performance-based tests to predict the Fleet Replacement Squadron (FRS) flight performance of aviators assigned to Squadron VFA-106 at Cecil Field, Florida, who were transitioning to the F/A-18.

METHODS

SUBJECTS

Sixty-seven jet fighter pilots performed on an automated cognitive/psychomotor test battery. Thirty-seven subjects were Category I pilots who averaged 27.17 years of age (<u>SD</u> = 1.56) with an average of 446.59 previous flight hours (<u>SD</u> = 296.03). Many of these subjects had been assigned to the F/A-18 directly after completing advanced undergraduate flight training. Thirty subjects were Category II pilots who averaged 30.93 years of age (<u>SD</u> = 3.97) with an average of 1554.03 previous flight hours (<u>SD</u> = 932.83). Many of them were transitioning to the F/A-18 from other operational fleet aircraft, typically A-7s or F-4s. Of the 67 subjects tested, 64 completed the fleet replacement squadron (FRS) program of training while three Category I pilots failed.

APPARATUS AND PROCEDURES

Table 1 lists the various tests given, the sequence of their occurrence, and the time required to administer each. The entire series was automated using an Apple IIe microcomputer, an Amdek Color I Plus monitor (CRT), and an Apple IIe numeric keypad. All test instructions were presented on the CRT to each subject before the st rt of each test.

TABLE 1. Sequence, Description, and Operating Times of Automated Tests.

Presentation order	Description	Test times (min) individual/cumulative
1.	Single psychomotor task (PMT), stick only (S)	10 / 10
2.	Single dichotic listening task (DLT)	23 / 33
3.	First multitask (1,2 combined)	05 / 38
4.	Single (PMT), stick & rudder (S&R)	13 / 51
5.	Second multitask (4,2 combined)	05 / 56
6.	Third multitask (4,2 combined)	05 / 61
7.	Single PMT; stick, rudder, & throttle (S&R&T)	07 / 68
8.	Second single PMT (like 7, S&R&T)	04 / 72
9.	Fourth multitask (8,2 combined)	06 / 78
10.	One dimensional compensatory tracking (ODCT)	10 / 88
11.	Absolute difference computation (ADC)	10 / 98
12.	Fifth multitask, ODCT & ADC (10,11 combined)	10 / 108

Psychomotor Task (PMT)

The psychomotor tracking task required subjects to maintain first one, then two, and finally three randomly displaced cursors on fixed targets on the CRT by manipulating joysticks and foot pedals. Subjects manipulated one Measurement Systems, Inc., joystick (stick or S), located at the front seat edge, with their right hand to control a cursor that was free to move throughout a rectangle covering approximately two-thirds of the CRT screen. The target position of this cursor was indicated by crosshairs bisecting this rectangular area, with the center point being slightly to the right and above the center of the screen. The stick controlled this cursor in a backwards (reversed) manner, that is, moving the stick to the right moved the cursor to the left while pulling the stick toward the subject moved the cursor up, et cetera. Locally produced rudder pedals (rudder or R), patterned after those of a Systems Research Laboratories, Inc., psychomotor test device and located directly below the table supporting the micro-computer and related equipment, were used to control a cursor that moved horizontally across the bottom of the screen. Pushing the left pedal moved this cursor to the right while pushing the right pedal moved it to the left. Another Measurement Systems joystick (throttle or T), located on the left seat edge, was manipulated by the subject's left hand to move a cursor vertically on the left side of the screen. Pulling this throttle back moved this cursor down while pushing it forward moved it up. During initial testing at VFA-106, the development of the throttle portion of the PMT was incomplete. Because of this, not all subjects were tested on the stick-rudder-and-throttle (S&R&T) task.

Psychomotor task tests 1, 4, and 7 (see Table 1) were each preceded by a 3-min practice period. The 6-min testing period of test 1 and the 9-min testing period of test 4 were each divided into 3-min testing sessions separated by 20-s rest periods. Tests 7 and 8 had a single 3-min testing period each. Psychomotor task scores were the accumulated total of absolute errors from an ideal target position in pixels. For each time sampling of cursor position, absolute pixel errors were assessed along each dimension separately. The final error score was the sum of all the samplings made across all the dimensions represented in that particular test. This error score was for the total time of that test, except for tests 1 and 4 where only the first 3-min session and the first two 3-min sessions, respectively, were analyzed. This error score total was then divided by the number of minutes of each test analyzed to generate a standard rate of pixel error per 1 min of test time. The scores of tests 5 and 6 and tests 7 and 8 were averaged for each subject. All of these PMT error scores were then transformed by using logarithms to base 10 in order to reduce skewness and to compensate for extreme outliers, thus reducing the complexity of data analysis while retaining all the data points available.

Dichotic Listening Task (DLT)

The DLT was patterned after a test described by Gopher and Kahneman (9), subsequently modified by Griffin and Mosko (10), and then automated at NAMRL. The DLT is an auditorally presented series of letter-digit string sets. Two Jameco JE 520-AP Voice Synthesizers were used to present these letter-digit strings at the rate of 0.7 s per item over binaural headphones to each subject at a listening level of 72 dB/Leq (re:20 pa). Subjects were instructed on each trial as to which ear to attend to, first for a series of 16 pairs of letters and/or numbers (Part I) and then again for a series of 6 more pairs (Part II). A visual example of a typical trial is given in Table 2. Subjects were to indicate the digits (0-9) presented to the designated ear in the order of their occurrence. Subjects responded with the left hand using a separate keypad placed immediately in front and slightly left of center. Responses could be made while the items were being presented or during an interval of 1.4 s after the presentation of the last letter and/or number pair. Five correct responses were possible on Part I and four on Part II of each trial, which together required 21 s to complete. The test was preceded by six auditorally presented practice trials that incorporated immediate performance feedback visually indicating the letters and digits presented and the subjects' keypad responses. Subjects also completed three multiple-choice questions before the start of this test to make certain that they understood the concept of the DLT.

The DLT performance measure was the number of incorrect responses made over 24 trials in which a total of 216 correct responses were possible. The number of correct responses made was divided by 2 and then subtracted from 109 (half the total possible correct plus 1) in order to make it directly comparable to the multitask DLT measures. This new adjusted error score was then transformed by using logarithms to base 10 to adjust for both skewness and extreme outliers as was done with the PMT results.

TABLE 2. Visual Example of a DLT Trial.

PART I	Left Ear		R 8 N S M Y 2 G B 7 F L 6 R L 5
	"Right"	(Vocal Channel 'attend' command)	
	Right Ear		Y L 3 S R 4 F Z 9 X F 0 F N 1 L
PART II	Left Ear		B F 4 3 7 9
	"Left"	(Vocal Channel 'attend' command)	
	Right Ear		G L 1 5 6 2

Multitask PMT/DLT

In all of the multitask conditions, subjects performed both the DLT and PMT simultaneously (a 12-trial DLT and a 4.5-min PMT). During the first multitask condition (test 3), subjects performed the DLT and the stick-only PMT (S). During the next two multitask conditions (tests 5 & 6), subjects performed the DLT and the stick-and-rudder PMT (S&R) using their right hand and both feet to control the central joystick and rudder pedals and their left hand to make keypad responses to the DLT input. During the final multitask condition (test 9), subjects performed the DLT and the stick-rudder-and-throttle PMT (S&R&T). In this most elaborate combination, subjects used their right hand and both feet to control the central joystick and rudder pedals as before but, in addition, used their left hand to control the throttle joystick and voiced their DLT responses using a microphone attached to the headphones. These vocal responses were tape-recorded for subsequent analysis and hand scoring. Before the start of the various multitask combinations, subjects were instructed to perform each task equally well.

Performance measures for the PMT and DLT in these multitask conditions were identical to those of the single tasks alone except for a different length of PMT testing and the presentation of 12 DLT trials in which a total of 108 correct responses were possible. The DLT began 15 s after the PMT and ended just before the PMT, with PMT errors being recorded for the final 4 min of that test. Figure 1 shows a subject performing the multitask PMT/DLT on the automated test apparatus.

One Dimensional Compensatory Tracking (ODCT)

The ODCT in general has been described (11) as follows. The task requires subjects to center a square-shaped cursor inside of an elongated rectangle by making, with their right hand, left and right movements of a joystick centered on the front seat edge. The cursor is driven by a forcing function, which increases centering effort with distance from center. During this phase of the task, subjects received three 2-min trials, with each trial separated by a 30-s rest period. The test measure for the ODCT was total pixel deviation error averaged over the three single-task trials.

Figure 1. Automated psychomotor/dichotic listening task.

Absolute Difference Computation (ADC)

Randomly selected digits between 1 and 9 were presented inside a small square in the middle of the CRT to subjects who then determined the absolute difference between the digit currently on display on the CRT and the last digit displayed previously. The subjects then pressed the corresponding digit-key on the keypad with their left hand as quickly as possible resulting in the display of another number for computation. Identical digits were not allowed to repeat. Only the digit responses 1, 2, 3, and 4 were possible. Subjects received three 2-min trials, with each trial separated by 20 s of rest. Performance measures for the ADC were the number of correct responses made and the average reaction time of these correct responses, both averaged over the three ADC trials.

Dual Task ODCT/ADC

During this phase of testing, subjects performed both the ODCT and ADC concurrently. The digits for the difference task were centered just above the tracking task. The subjects controlled the tracking task joystick with their right hand and made keypad responses to the difference task with their left hand. Subjects were instructed to perform each task equally well. Subjects received three 2-min trials with each trial separated by 30 s of rest. Test measures for the dual task ODCT/ADC were the same as those for the single tasks. Figure 2 shows a CRT screen display from the dual task ODCT/ADC.

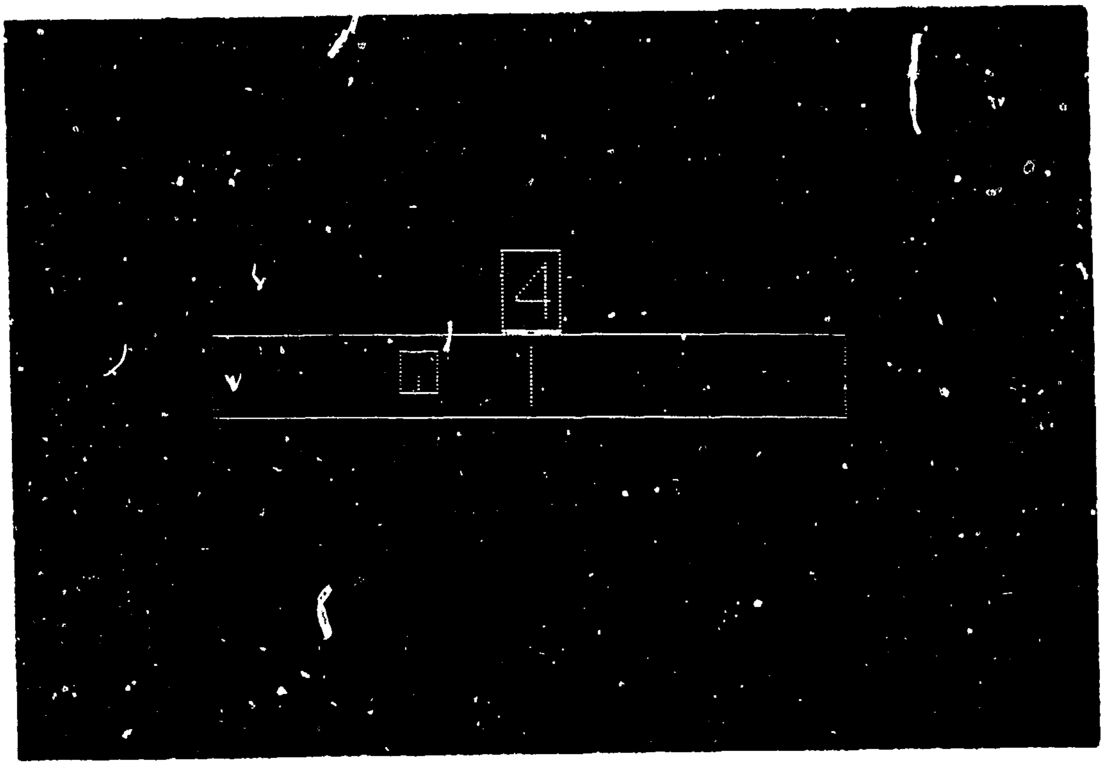

Figure 2. The CRT display for dual-task ODCT/ADC.

Operational Performance Criteria

Aviators undergoing FRS training at VFA-106 receive a series of grades comparing their performance to that of others undergoing this training. Specifically, they are graded on their performance in the Transition (TRAN), Basic Fighter Maneuvering (BFM), Gunnery (GUN), Visual Intercept (VID), Fighter Weapons Training (FWT), Navigation (NAV), Light Attack (LAT), Strike (STK), and Carrier Qualification (CQ) portions of the VFA-106 training program. The overall grade (OAG) is an equally weighted composite of all of these individual FRS grades.

RESULTS

AVIATOR FRS PERFORMANCE

Using one-way analysis of variance (ANOVA), we found significant differences between Category I and II aviators on most of the FRS grades (Table 3). For every FRS grade, the average score of Category II pilots was higher than that of Category I pilots. At least two explanations are plausible. First, Category II pilots may have performed better on these measures because they had more accumulated flight hours in and out of jet aircraft. A second reason could be that some element of the scoring procedure had biased these scores in favor of the Category II pilots. This could be due to the fact that the Category II pilots were scored by their peer group while the Category I pilots were not.

TABLE 3. Descriptive Statistics for FRS Grades: Category I and II Aviators.

RS grade	Category I Mean	SD	n	Category II Mean	SD	n	F	p
TRAN	3.08	0.03	35	3.10	0.03	30	11.46	.0016
BFM	3.12	0.06	35	3.15	0.05	30	5.46	.0214
GUN	3.08	0.04	34	3.10	0.04	29	1.37	>.05
VID	3.10	0.04	35	3.12	0.07	30	1.74	>.05
FWT	3.11	0.04	34	3.14	0.04	30	10.63	.0022
NAV	3.09	0.06	35	3.12	0.05	29	5.66	.0194
LAT	3.08	0.04	35	3.12	0.03	29	13.55	.0008
STK	3.07	0.03	35	3.10	0.02	29	14.71	.0005
CQ	2.94	0.12	34	3.07	0.14	27	14.65	.0006
OAG	3.08	0.02	34	3.11	0.03	29	27.53	.00003

AVIATOR TEST BATTERY PERFORMANCE

In this study, two identical testing stations were utilized, and subjects were randomly assigned to one of these two. These two stations did not differ significantly in terms of pilot test performance. Table 4 presents descriptive statistics on the performance of both Category I and Category II FRS pilots on the psychomotor and cognitive tests as well as flight hours and age. Not all test scores were obtained for all subjects due to scheduling problems and apparatus malfunctions. One-way ANOVAs showed no significant differences between Category I and II aviators on any of these tests. They did differ significantly, however, in age ($F(1, 65) = 46.52$, $p < .00001$) and flight hours ($F(1, 63) = 26.63$, $p < .00004$). As noted earlier, the two categories of pilots were identified and treated differently at the FRS. Because of this and the differences found in FRS grades, we analyzed the data for each pilot category group separately.

For both pilot groups, the mean number of errors made on the PMT, regardless of motor complexity level, decreased when the DLT was added. Two-tailed t tests for dependent samples showed this difference to be significant for all conditions (all t values > 6.24, all p values < .01) and would indicate that the subjects performed better when the PMT and DLT were combined. A more parsimonious explanation involves the fact that, as the DLT was brought on line with the PMT, the particular microcomputer used could not maintain the level of cursor positioning difficulty attained previously due to processor overload. This overloading also produced a possible reduction in error sampling rate as test complexity increased. An apparent decrease in testing efficiency does not invalidate the usefulness of these results or methodology in predicting flight performance, but it does call for a possible change/upgrade in computer equipment. In this regard, using Friedman two-way ANOVAs (12), we found that for both category groups, subjects made significantly more errors as PMT complexity increased during both the unitask and multitask conditions (all ANOVA Chi-square's > 34.10, all $df = 2$, all p values < .01).

TABLE 4. Descriptive Statistics of Tests: Category I and II Aviators.

Test measure	Category I Mean	SD	n	Category II Mean	SD	n
Unitask DLT	0.70	0.25	35	0.71	0.21	30
Multitask DLT w/(S)	0.64	0.39	36	0.67	0.35	30
Multitask DLT w/(S&R)	0.76	0.29	36	0.72	0.28	30
Multitask DLT w/(S&R&T)	0.89	0.39	18	0.84	0.22	18
Unitask PMT (S)	3.05	0.11	35	3.01	0.16	29
Multitask PMT (S) w/DLT	2.74	0.14	37	2.73	0.17	30
Unitask PMT (S&R)	3.38	0.10	35	3.40	0.15	29
Multitask PMT (S&R) w/DLT	3.15	0.17	37	3.13	0.17	30
Unitask PMT (S&R&T)	3.55	0.08	18	3.57	0.20	19
Multitask PMT (S&R&T) w/DLT	3.38	0.13	18	3.35	0.15	18
Single tracking (ODCT)	22.61	5.39	29	24.21	9.58	12
Sgle abs diff. (ADC)	55.78	13.93	29	59.03	11.32	12
Sgle abs diff. (ADC) RT	2.35	0.44	29	2.20	0.35	12
Dual tracking (ODCT)	31.81	9.17	29	38.95	14.85	12
Dual abs diff. (ADC)	60.28	15.12	29	62.53	7.69	12
Dual abs diff. (ADC) RT	2.24	0.58	29	2.05	0.22	12

TEST BATTERY/FRS PERFORMANCE CORRELATIONS

Individual Pearson product-moment correlations were performed among the various test battery measures and the FRS grades. Of these 160 correlations, only 5 (3%) were significant ($p = .05$) for the Category I aviators while only 12 (8%) were significant for the Category II aviators. Generally, this would be expected merely by chance. Also, the arrangement of significant correlations was unique for each pilot category and, for the most part, did not follow any logically obvious pattern. This became evident when attempting to explain both the dissimilar significant correlations found between very similar tests, some of which were in the direction opposite to that expected, and the lack of similar significant correlations among FRS grades that appeared to be tapping into similar piloting skills. As a check of true significance, we performed canonical correlation analysis (13), a generalization of multiple regression analysis for any number of dependent variables, on both pilot categories. Given the nature of this analysis, only test battery measures with an $n > 20$ were included, and the OAG score was excluded due to its redundant composite nature. Neither the Category I (Canonical $R = .98$, Chi-square = 134.26, $df = 117$, $p = .131$) nor the Category II (Canonical $R = .86$, Chi-square = 72.19, $df = 63$, $p = .200$) results were significant. Also, no significant correlations were found between either age or flight hours and any of the FRS grades for either pilot category.

CONCLUSIONS AND RECOMMENDATIONS

The results of this study indicate virtually no significant relationships between performance on this test battery and FRS performance for this particular type of aviator. Specifically, those cognitive and psychomotor abilities assumed to be measured by this test battery were not significant factors in FRS performance. Quite possibly, for any group of experienced pilots, results from such a battery would not correlate significantly with such operational performance measures. This would most likely be due to the fact that the skill and ability levels found in such a subject group would have already been significantly equalized across subjects as a consequence of common selection, training, and flight experiences. If so, whatever test performance variance was found within this subject group would be mostly due to factors different from those producing the variance seen in the FRS grades.

We recommend continued research of this type utilizing this test battery be continued with some changes. Differences in test performance among both similar and different pilot-type groups should be investigated as thoroughly as possible. Replication is crucial if this testing methodology is to be considered for purposes of selection and assignment in naval aviation. Changes in test structure that would increase testing efficiency, or apparatus that would increase or at least stabilize test subject effort should be investigated. Also, research in which subjects are tested before flight training and then followed throughout their aviation career is needed. Such long-term studies would allow a more accurate assessment of the predictive ability of these tests choosing the best candidate for a particular aviation platform or community.

REFERENCES

1. Rickus, G.M., Jr. and Berkshire, J.R., Development of an Aviation Combat Criterion: Criterion Report, NAMI-1047, Naval Aerospace Medical Institute, Pensacola, FL, August 1968.

2. Bale, R.M., Rickus, G.M., Jr., and Ambler, R.K., Replacement Air Group Performance as a Criterion for Naval Aviation Training, NAMRL-1126, Naval Aerospace Medical Research Laboratory, Pensacola, FL, December 1970.

3. Ciavarelli, A.P., Brictson, C.A., and Young, P.A., Development and Application of Performance Criteria and Aircrew Assessment Methods for the Air Combat Maneuvering Range (ACMR), NAMRL Special Report 79-5, Naval Aerospace Medical Research Laboratory, Pensacola, FL, December 1979.

4. Brictson, C.A., Burger, W.J., and Gallagher, T.J., "Prediction of Pilot Performance during Initial Carrier Landing Qualifications." Aerospace Medicine, Vol. 43, pp. 483-487, 1972.

5. Shannon, R.H., Waag, W.L., and Ferguson, J.C., A New Approach to Criterion Development in the Replacement Air Group, NAMRL-1158, Naval Aerospace Medical Research Laboratory, Pensacola, FL, July 1973.

6. Shannon, R.H. and Waag, W.L., Toward the Development of a Criterion for Fleet Effectiveness in the F-4 Fighter Community, NAMRL-1173, Naval Aerospace Medical Research Laboratory, Pensacola, FL, December 1972.

7. Shannon, R.H. and Waag, W.L., The Prediction of Pilot Performance in the F-4 Aircraft, NAMRL-1186, Naval Aerospace Medical Research Laboratory, Pensacola, FL, July 1973.

8. Griffin, G.R., Morrison, T.R., Amerson, T.L., and Hamilton, P.V., Predicting Air Combat Maneuvering (ACM) Performance: Fleet Fighter ACM Readiness Program Grades as Performance Criteria, NAMRL-1333, Naval Aerospace Medical Research Laboratory, Pensacola, FL, October 1987.

9. Gopher, D., and Kahneman, D., "Individual Differences in Attention and the Prediction of Flight Criteria." Perceptual and Motor Skills, Vol. 33, pp. 1335-1342, 1971.

10. Griffin, G.R., and Mosko, J.D., Preliminary Evaluation of Two Dichotic Listening Tasks as Predictors of Performance in Naval Aviation Undergraduate Pilot Training, NAMRL-1287, Naval Aerospace Medical Research Laboratory, Pensacola, FL, July 1982.

11. Damos D.L., and Gibb, G.D., Development of a Computer-based Naval Aviation Selection Test Battery, NAMRL-1319, Naval Aerospace Medical Research Laboratory, Pensacola, FL, August 1986.

12. Siegel, S., Nonparametric Statistics for the Behavioral Sciences, McGraw-Hill Book Co., New York, 1956.

13. Kerlinger, F.N., and Pedhazur, E.J., Multiple Regression in Behavioral Research, Holt, Reinhart and Winston, Inc., New York, 1973.

Other Related NAMRL Publications

None are applicable.